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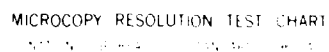
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AFGL-TR-87-0299

Support for FY87 Midlatitude
Electron-Density Calibration Campaign

John M. Lansinger

AD-A190 174

Northwest Research Associates
P.O. Box 3027
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15 October 1987

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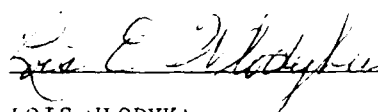
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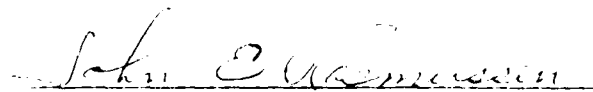
AIR FORCE GEOPHYSICS LABORATORY
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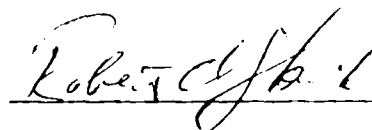


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SUPPORT FOR FY87 MIDLATITUDE ELECTRON-DENSITY CALIBRATION CAMPAIGN

I Introduction

One of the applications of data from AFGL's Auroral and Ionospheric Remote sensor (AIRS) aboard the Polar BEacon and Auroral Research (Polar BEAR) Satellite is an attempt to produce electron-density profiles from remote passive topside sensing. During development of techniques for this challenging procedure, AIRS data are needed that are simultaneous and closely co-located with data from an independent, established technique. To provide such data was the objective of TRN 10.

To accomplish this objective, the transportable HiLat/P BEAR beacon and telemetry receiver, Rover, developed and operated by Northwest Research Associates (NWRA) for the Defense Nuclear Agency (DNA), received data from P BEAR (which contains no on-board recording capability) while the satellite over-flew the Millstone Hill incoherent-scatter radar. The radar provided "ground-truth" information on ionospheric electron-density profiles, as well as measurements of electron and ion temperature, plasma drift, and the thermospheric neutral wind, during selected satellite passes between 1 July and 11 August 1987. In addition to recording the down-link science data, Rover provided real-time AIRS information to ground-support equipment during the course of the scheduled field measurements.

II FIELD PREPARATIONS

Rover was operated, for mutual DNA/AFGL interests, at Poker Flat, AK, until 8 June 1987. Thereafter, NWRA prepared it for transport and shipped it to Hanscom AFB on 12 June. NWRA personnel arrived on site 22 June and commenced test operations on 24 June. Upon request from NWRA, the Naval Astronautics Group at Pt. Mugu, CA, reset the P BEAR instrument timer for lower-latitude operation, which became effective 27 June, thereby allowing full horizon-to-horizon coverage at Hanscom Field.

Test operations involved recording the raw data from passes selected from the pass plan. The Rover on-line and printer outputs indicate the number of science data frames recorded as a function of time. Adequate operation is confirmed when all data above approximately 10 degrees elevation angle are recovered successfully.

Table 1 summarizes the data base collected during test operations. The relatively low number of telemetry frame records recorded on Day 177 (26 June) was caused by turn-off of the beacon at 45 degrees latitude, which is normal for high-latitude operation. Subsequent passes had full coverage because of the timer reset.

Table 1 Summary of Polar BEAR Passes Received and Processed at AFGL During the Test Phase of the
Midlatitude Electron density Calibration Campaign

Day	GMT Start Time	Maximum Elevation of Pass (degrees)	Telemetry Frame Records Received and Processed
177	05 05	47.1	687
179	17 52	63.5	1,577
180	16 37	37.8	1,404
180	18 22	34.7	1,603
181	17 06	68.9	0
182	17 36	67.2	1,616

The absence of telemetry frame records on day 181 (30 June) was caused by a faulty cable connector during the initial field tests. The faulty connector was corrected, and for the remainder of the operations no further difficulties were encountered related to this problem.

Upon verification of adequate Rover performance, personnel from NWRA and the Applied Physics Laboratory (APL) of Johns Hopkins University established an interface between Rover and APL's AIRS ground-support equipment (GSE). Figure 1 shows the details of the GSE interface required to obtain real-time AIRS observations from the Rover operations. This involved routing the down-link data stream from the integrate-dump-and-decode circuit board and the bit clock reference from the data clock circuit board in Rover to an interface board that provided an NRZ Bi-Phase Mark waveform utilized by the GSE.

Arrangements were made for the Millstone Hill incoherent scatter radar operations to provide ground-truth data sets corresponding to selected daytime passes of P-BEAR during the operation of the campaign. Raw data were made available for computer access by AFGL/NWRA personnel, and hard copies of electron-density contour plots, electron temperature contour plots, drift temperature, and electric field data were scheduled to be provided.

III FIELD OPERATIONS

Table 2 summarizes the P-BEAR passes that were received and recorded at AFGL during the ground truth campaign which extended from 1 July through 11 August. All 60 passes selected from the P-BEAR pass plan for the period were received and recorded. On Day 186 (4 July) P-BEAR was acquired at less than 10 degrees elevation and ascended to a maximum elevation angle of 28 degrees at which point the beacon signal no longer was received. No operational failure could be found with Rover to explain this sudden loss of data which resulted in only 513 science frames of data being received for this isolated satellite pass. From perusal of the recorded data base given in Table 2, it is evident that all other passes received during the operational portion of the campaign resulted in a normal complement of data frames.

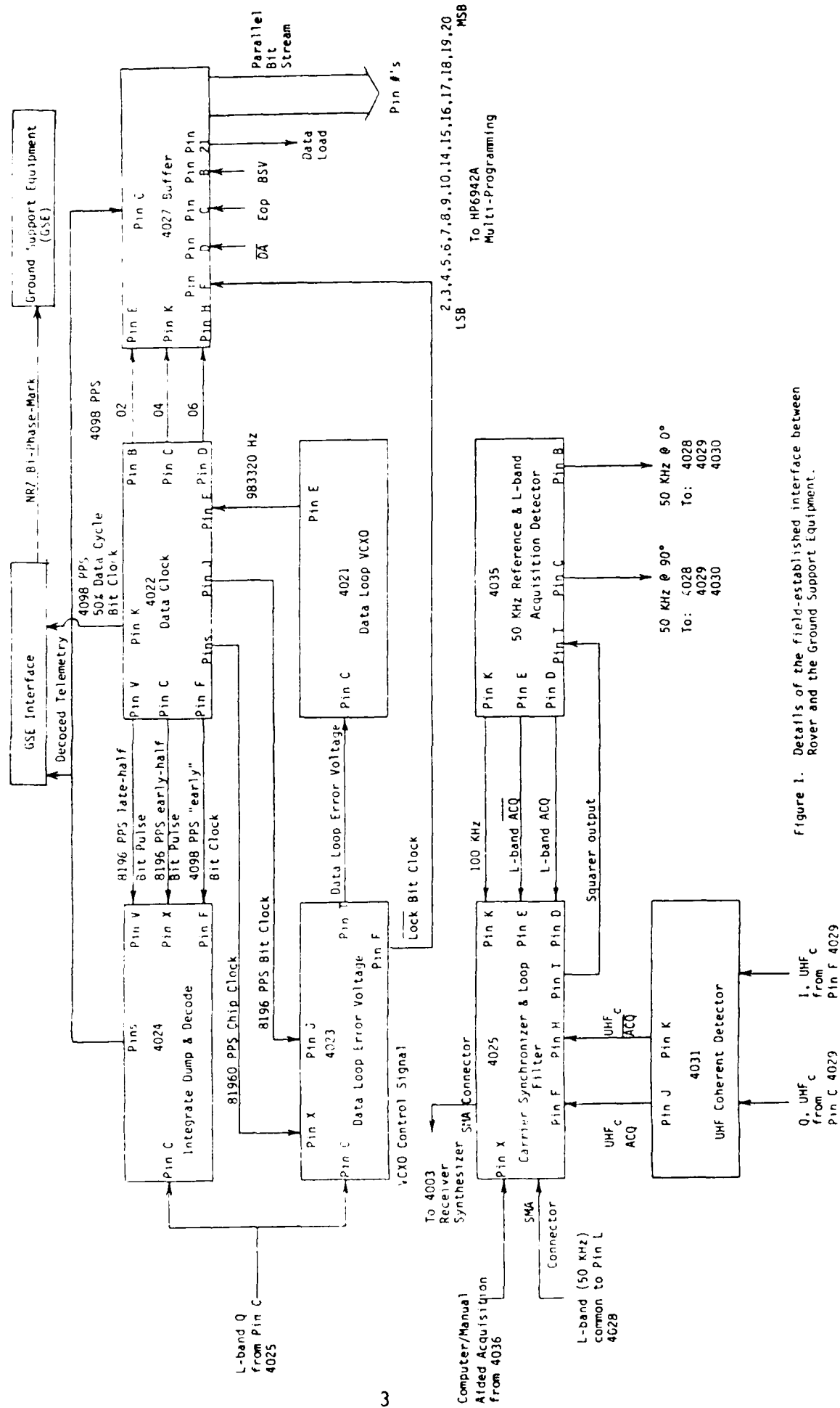


Table 2 Summary of Polar BEAR Passes Received and Processed at AFGL During the Midlatitude
Electron-density Calibration Campaign

Day	GMT Start Time	Maximum Elevation (degrees)	Telemetry Frame Records Received and Processed
183	16:21	35.9	1,437
183	18:06	36.7	1,650
184	16:51	65.3	1,570
185	17:21	70.9	1,620
186	16:06	34.2	1,432
186	17:51	28.1	513
187	16:36	62.0	1,604
188	17:05	74.7	1,577
189	15:51	32.5	1,537
189	17:35	41.2	1,627
190	16:20	50.0	1,573
191	16:50	78.4	1,538
192	15:35	30.9	1,386
192	17:30	43.4	1,548
193	16:04	55.7	1,577
194	16:34	82.1	1,576
195	15:20	29.4	1,380
195	17:04	45.9	1,587
196	15:49	52.8	1,577
196	17:34	25.4	1,604
197	16:19	86.3	1,536
198	15:05	27.9	1,358
198	16:49	48.5	1,643
199	15:34	50.0	1,506
199	17:19	26.8	1,498
200	16:04	87.7	1,533
201	14:49	26.5	1,336
201	16:33	51.2	1,577
202	15:18	47.4	1,519
202	17:02	28.3	1,643
203	15:48	84.4	1,536
204	16:17	54.0	1,636
205	15:03	44.9	1,496

Table 2. (continued)

Day	GMT Start Time	Maximum Elevation (degrees)	Telemetry Frame Records Received and Processed
205	15:03	44.9	1,496
205	16:48	29.8	1,601
206	15:33	80.6	1,640
206	17:20	16.2	1,235
207	14:19	23.8	1,295
207	16:02	57.0	1,639
208	14:47	42.5	1,531
208	16:32	31.4	1,657
209	15:17	76.7	1,597
209	17:02	17.1	1,487
210	14:04	22.5	1,304
210	15:47	60.1	1,640
211	14:33	40.2	1,451
211	16:17	33.0	1,670
212	15:02	72.8	1,608
212	16:47	16.1	1,541
213	13:48	21.3	1,282
213	15:32	63.4	1,637
214	14:17	38.1	1,438
214	16:01	34.7	1,698
215	14:46	69.1	1,578
215	16:31	19.1	1,613
216	13:33	20.1	1,245
216	15:16	66.8	1,635
217	14:02	36.0	1,381
217	15:46	36.6	1,697
218	14:31	65.5	1,580
218	16:16	20.1	1,601
219	13:18	18.9	1,235
219	15:01	70.4	1,628
220	13:46	34.1	1,470
220	15:30	38.5	1,696
221	14:15	61.9	1,639
221	16:01	21.2	1,612
222	14:45	74.3	1,656
223	15:15	40.5	1,502

NWRA terminated tracking of the P-BEAR satellite and processed B-10 data shipment to Bellevue, WA, and the shipper removed B-10 from the shipper's list.

IV. ATTITUDE DETERMINATION

During the campaign, the Air Force Research Laboratory at NWRA's Bellevue, WA computing facility, raised a series of questions as to whether attitude of the satellite could be suitably determined from the imagery data for a subset of the passes monitored during the campaign. Communication with AFGL personnel revealed that, in order to find out at AFGL, the geometry of P-BEAR was such that severe limitations arose in the capability of attitude determination. This was a result of the spatial ratios of sun and magnetic field directions being nearly colinear. Additional geometrical limitations were caused by the Z axis of the satellite being nearly aligned with the sun direction, which resulted in shading of the sun sensor(s) by portions of the satellite. No attitude determinations could be made during major portions of several passes monitored during the campaign, because the sun sensors were in the dark due to this shading problem.

It was necessary to reconstruct the missing attitude data using Kalman-filter techniques. Software was developed by AFGL for such application to the Naval Navigation Satellite System, and it has been installed on NWRA's IBM-compatible PC similar to equipment used for analysis processing of AIRS data at AFGL. Collectively, NWRA suggest feasibility of reconstructing the missing attitude data, but software enhancement will be required to do so.

V. DELIVERABLES

Data from all passes collected during the campaign have been processed in Bellevue. Twenty-seven duplicate raw tapes and five tapes containing summary data were shipped from the NWRA facility on 2 October. Arrangements have been made for delivery of the incoherent-scatter radar data from Millstone Hill to Frank DeGrego.

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